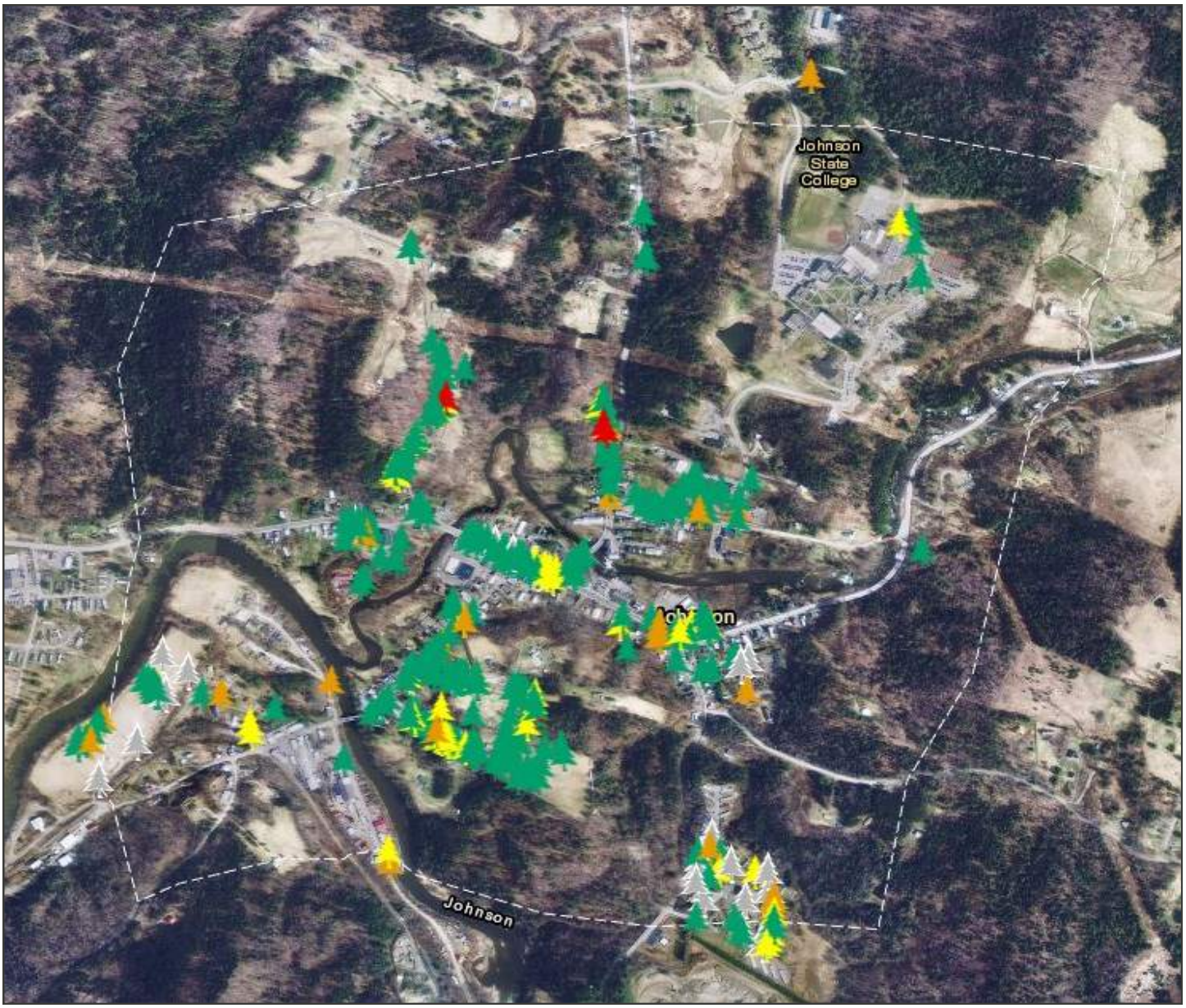
Johnson Public Tree Inventory Report



Prepared for the Town of Johnson Tree Board
by the Vermont Urban & Community Forestry Program
November 2014

VERMONT
AGENCY OF NATURAL RESOURCES

PLANT LIVE GROW
VERMONT URBAN & COMMUNITY FORESTRY PROGRAM

Acknowledgements

Thanks to the Johnson Tree Board (Sue Lovering, Noel Dodge, Dorcas Jones, Court Perry, Louise VonWeis) for supporting the work presented in this inventory report. For their participation in the data collection, thanks to Sue Lovering, Noel Dodge, and Lois Frey from Johnson and to David Wilcox, State Lands Forester for the State of Vermont. Finally, thanks to the Vermont Urban & Community Forestry Program's fall 2014 intern, Andrea Urbano, for analyzing the data and drafting this report.

About the Vermont Urban & Community Forestry Program

The field of forestry management is not confined to the natural areas and forests of Vermont, but extends to the urban and rural spaces where trees play important roles. The trees in public parks, along roadsides, town greens, and municipal forests compose our urban and community forests and merit careful stewardship. The Vermont Urban & Community Forestry Program (VT UCF) is a collaborative effort between the Department of Forests, Parks, & Recreation, the University of Vermont Extension, and the USDA Forest Service. The program provides technical and financial assistance as well as educational programs and resources for the management of trees and forests in and around Vermont communities. The mission of VT UCF is ***to lead citizens, businesses, and governments in understanding the value of urban and community forests and promote civic responsibility for and participation in the stewardship of these resources for this and future generations.*** Since 1991, the program has been guided by a small staff and a twenty-member advisory council. The council meets quarterly to share information and advise the program; its members come from various professional associations, non-profits, educational institutions, tree boards, regional officials, and state agencies.

The trees in our communities offer a wide variety of environmental, social, and economic benefits to the surrounding community, including stormwater control, CO_2 sequestration, and aesthetic value. VT UCF seeks to maximize these benefits by working with state and municipal officials and dedicated volunteers to steward the urban forest's ecological integrity and diversity. VT UCF's programming and support reaches 100 Vermont

communities annually and has brought more than $1 million in grants to further urban and community forestry statewide. More information about VT UCF and its programming can be found at www.vtcommunityforestry.org.

This document is a report on the recent (September 2014) inventory of public trees in the downtown and most densely populated areas of Johnson, Vermont (Johnson Village). The report is intended to inform stakeholders in Johnson of their community's current tree species composition and overall condition. The inventory report is the first step in developing a well-informed urban forest management plan for Johnson.

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Executive Summary

The goal of the public tree inventory was to document the location, size, species, and condition of trees planted, and to identify suitable locations for future tree plantings within the public right-of-way (ROW) and on town-owned land within the most densely-populated areas of Johnson (Johnson Village). The information gathered from the Johnson Village inventory provides residents and decision-makers with a better understanding of the health and benefits of Johnson's urban forest and will allow the Johnson Tree Board to plan future tree planting and maintenance using a map-based tree inventory system.

The inventory was coordinated and conducted with the Johnson Tree Board. Community volunteers and VT UCF staff and an intern completed an inventory of **363 trees** located within the ROW of 18 streets and on 7 town-owned properties, and identified 20 specific locations or strips of public land appropriate for future tree plantings. Staff from VT UCF provided inventory data collection training and technical assistance needed to complete the inventory. This report was prepared in the fall of 2014 by the VT UCF program staff and an intern. It presents the results of the Johnson public tree inventory and provides a basic assessment of the trees and canopy cover in Johnson Village.

Local government, conservation agencies, and private landowners all play an important role in monitoring and maintaining urban forests. Urban trees provide a number of community benefits, such as reducing stormwater runoff, reducing air pollution, providing shade, sequestering and storing carbon, enhancing property values, sustaining wildlife, and improving the aesthetics of the community. The 363 inventoried public trees provide an estimated **$29,003 in annual benefits** to Johnson Village residents. The tree canopy assessment of the full inventory area (Johnson Village) indicated an **existing canopy cover of 50%** and a current carbon storage value of **over one million dollars**.

Summary of findings:

Forest Diversity

- Of the 363 inventoried public trees, there are 45 different species in 22 different genera.

- The top five most common tree genera: *Acer* (maple), *Pinus* (pine), *Betula* (birch), *Fraxinus* (ash), and *Malus* (apple), make up 70.25% of the urban forest.
- *Acer* and *Fraxinus* species represent 42.98% of Johnson Village's urban forest. Invasive tree pests currently threaten both of these genera: the Asian longhorned beetle (ALB) and the emerald ash borer (EAB), respectively.
- The top five most common species: *Acer saccharum* (sugar maple) (19.01%), *Pinus strobus* (eastern white pine) (14.33%), *Betula* species (river and paper birch) (8.26%), *Acer negundo* (boxelder) (5.79%), and *Acer rubrum* (red maple) (5.23%). In total, these species comprise 50.96% of Johnson Villages' stocking.

Forest structure

- The majority of Johnson Village trees (95 trees or 26.17%) have diameter measurements between six and twelve inches.
- 67 (18.46%) trees have a diameter between zero and three inches.
- 61 (16.80%) trees have a diameter between twelve and eighteen inches.
- 56 (15.43%) trees have a diameter between three and six inches.
- The remaining 84 (23.14%) are greater than eighteen inches in diameter.

Forest Cover

- There is an existing urban tree canopy (UTC) cover of 50% in Johnson Village. This includes both public and private trees.
- Trees could potentially cover an additional 45% of the Village's land surface; these "possible UTC" areas include low-lying vegetation or grassland, agricultural land, and impervious surfaces (e.g. parking lots, paved playgrounds, and the ROW).
- Buildings, water, and other permanent features that are unsuited for UTC improvement comprise the remaining 5% of the Johnson Village's area.

Forest health

- The majority (280 trees or 73.13%) of Johnson Village's inventoried trees were assessed as being in "good" condition. The remaining 83 trees were considered to be

in “fair” (12.95%) or “poor” (7.99%) condition. Seven (1.93%) inventoried trees were dead.

- 51 (14.04%) trees were flagged as in need of a consultation.

Benefit output

- The total annual energy (electricity and natural gas) benefits of all inventoried trees in Johnson Village are valued at $14,815.68.
- Johnson Village public trees intercept 458,677.99 gallons of rainfall each year, yielding an annual storm water cost benefit of $3,669.42.
- Johnson Village public trees currently store 992,015.27 lbs. of carbon.
- The annual aesthetic benefit of Johnson Village’s public trees is valued at $7,591.20.
- When considering all the benefits trees have on a community (energy, carbon, air quality, storm water and aesthetic), Johnson Village public trees have a total average annual benefit value of $80 per tree and cumulative annual benefit of $29,003.00. There are currently no costs associated with Johnson Village’s tree maintenance.

Summary of recommendations

The Johnson public tree inventory results provide insight into developing community forest management recommendations. Although Johnson’s urban forest is fairly diverse in its species composition, we recommend officials implement the following recommendations:

Encourage long-term species and age diversity. This should be a management priority for Johnson Village, as nearly 50% of its species composition is within *Acer* and *Fraxinus* genera. Maintaining and increasing species diversity within the Village will ensure the long-term health of individual trees and the complete urban forest by reducing the threat and spread of the invasive pests currently threatening these genera (ALB and EAB respectively). Twenty-three percent of Johnson Village’s public trees are in older ages classes (diameter at breast height, or DBH, of eighteen inches or greater). The majority of the most common tree species (sugar maple and eastern white pine) found in Johnson

Village's community forest fall within this age class and should be more closely monitored. Plantings should compensate for expected mortality of these older trees.

Monitor tree health, specifically for signs and symptoms of emerald ash borer (EAB) or Asian longhorned beetle (ALB), and other forest pests and diseases. Invest more monitoring attention on the 23% of trees with a diameter 18 inches and greater, as larger (and typically older) trees can be more susceptible to stress.

Maintain tree health by ensuring that those who are caring for Johnson Village's public trees are trained in best tree care practices; prune all public trees to promote long-term structural integrity, irrigate newly-planted trees, and prevent mechanical damage to trees. We also recommend the Tree Board or Tree Warden perform routine consultations on the 14% of trees identified as in need of consult, and on the species classified in "fair", "poor", or "dead" conditions.

Update the Inventory of Johnson Village's public trees every five years.

Establish a routine systematic trimming cycle for all public trees to reduce future tree failures due to poor structure, minimize conflicts with people and infrastructure, improve lines of sight, reduce storm damage, and protect public safety.

Develop a comprehensive management and urban forest master plan based on this inventory report, and ensure it compliments the Town's existing EAB Preparedness Plan.

Communicate the benefits of Johnson Village's public trees at local events. Use the Johnson Tree Board link within the Town's website to share information and educate citizens. Recruit additional members for the Johnson Tree Board to increase local stewardship, and encourage participation in VT UCF educational programming such as the *Stewardship of the Urban Landscape* course and the *Forest Pest First Detectors* trainings.

Volunteers from the Johnson Tree Board joined VT Urban & Community Forestry Program staff and an intern for two days of data collection in September.

Introduction

Project Description

The VT UCF program currently has a grant from the USDA Forest Service to assist twenty priority communities in Vermont in advancing their forestry programs. The project, *Care of the Urban Forest*, is a multi-year effort that aims to support these communities in three specific ways: (1) conducting a public tree inventory to assess urban forest structure, composition, and health; (2) helping the community develop an urban forest management plan (or master plan) using information from the inventory; and (3) providing technical training for volunteers and town employees to promote the proper care and management of public trees.

The Johnson Tree Board was eager to partner with VT UCF when presented with the opportunity to participate in the *Care of the Urban Forest* project. The goal of the public tree inventory was to document the location, size, species, and condition of trees planted within the public right-of-way (ROW) and on town-owned land within the Village. The inventory also served to identify suitable locations for future tree plantings. Community volunteers and VT UCF staff and interns conducted a comprehensive public tree inventory over the course of two days. This inventory establishes a baseline for future inventories, management decisions, and improvements to Johnson's urban forest.

Building on the momentum of the recently-written Johnson EAB Preparedness Plan (to review plan, visit VTinvasives.org) and the 2014 establishment of the Johnson Tree Board, participation in the Care of the Urban Forest project continues to move Johnson's tree stewardship program forward. The forest condition and benefits data generated from this inventory is intended to inform the Town's educational and managerial community forestry decisions.

Johnson Village Community Profile

Historically, the Town of Johnson was considered part of its neighboring town, Cambridge. This area was jointly known as the King's College Tract. A royal charter of British King George III established the King's College Tract in 1774. After the Declaration of Independence, the Vermont Council of Censors granted the town to William Samuel Johnson, an American jurist, statesman and educator. The Town of Johnson was chartered by Vermont in 1792 and is located in Lamoille County. Johnson is nestled northeast of the Mt. Mansfield State Forest and south of the Long Trail State Forest. The Town of Johnson spans 45.1 square miles, and harbors Johnson Village, a 1.2 square mile area built around the Lamoille River. As of the 2010 US population census, the Town of Johnson inhabits 3,446 people, 1,443 of whom populate Johnson Village. Johnson Village is perhaps most well known as the location of Johnson State College and Johnson Woollen Mills, but also has a rich tradition of farming and horse keeping. The Village of Johnson is home to a number of antique shops, several small eateries, gift shops, world-class craft producers, and an art school.

Methodology

Prior to the public tree inventory, VT UCF staff met numerous times with the Johnson Tree Board to plan for the inventory. Through the planning

Importance of Inventory and Urban Forestry in Vermont

An inventory of urban trees provides a record of the trees present in a community. An inventory can provide information about the species, size, health, and location of each tree and future management needs. This detailed information allows town planners to estimate the monetary contributions of their community's green infrastructure. In the event of a disease outbreak or insect infestation, data from an inventory may assist in monitoring and preventing the spread of a forest health epidemic. An inventory can also help build public support for expanding community forests and to guide future urban planning.

Urban trees improve the quality of life for Vermont communities in a variety of ways. The most readily apparent benefit is the aesthetic value that trees provide a street, home, or public space. Along with this beauty is the functional benefit of providing shade along the streets in the summertime and blocking wind to reduce heating costs in the wintertime. The presence of trees has been shown to positively affect property values (Morales 1973; 1983) and boosts foot traffic in commercial areas. Parks and tree-lined sidewalks promote physical activity by creating shaded, comfortable outdoor spaces. Many types of urban wildlife depend on trees as sources of food and shelter. Unseen environmental benefits of urban trees include improvements in air quality and temperature regulation through reduction of the heat island effect. Trees can mitigate noise pollution common in an urban environment and can clean and conserve water by controlling run-off. Additionally, urban forests create opportunities for environmental education, community engagement and in some instances can be related to crime reduction. Trees are an integral part of the green infrastructure of a community and contribute to keeping our families healthier and our everyday lives more fulfilling.

process, 30 streets and 8 town-owned properties within the 1.2 square mile area of Johnson Village were identified to be included in the public tree inventory (as seen in Appendix A, trees were found and inventoried on 18 of the streets and 7 of the properties). The Johnson Planning and Zoning Office provided the ROW boundaries for all inventoried streets. The list of streets and sites with ROW boundaries is found in Appendix A and maps of the inventory area are found in Appendix C.

VT UCF has developed an inventory system in collaboration with the VT Agency of Natural Resources' (ANR) GIS team. The map-based inventory system uses the application "Collector", created by ArcGIS for data collection. Collector is linked to the ANR Atlas online mapping tool.

On September 8th and 10th, 2014, Johnson Village volunteers and VT UCF staff and intern split into teams and walked along pre-designated streets and sites of Johnson Village, inventorying the public trees and identifying appropriate potential planting locations or green strips (recorded as "Vacant"). To ensure that only public trees were inventoried (opposed to trees on private property), each team had a list of the ROW boundaries for each street. The inventory teams first determined the extent of the ROW from the curb; they measured the road width, subtracted that number from the full ROW boundary, and then divided the number in half to determine the ROW extent on each side of the street. The following equation expresses this process:

ROW distance from curb = (ROW width - road width)/2

Each public tree identified was recorded into the "Collector" application using an iPad provided by VT UCF. "Collector" is map-based and uses GPS and a base layer map to allow the user to input tree information, linking it to a particular geographic location. Data recorded for each tree included condition, tree number, street name, species, diameter class (using a diameter at breast height [DBH] measurement), consultation recommendation, comments, and nearest house or building number. A photo of each

inventoried tree was taken and uploaded to its data entry. A full list and description of the parameters used in data collection can be found in Table 1.

Table 1: Parameters for Inventory Data Collection

Data Parameters	Description
Site ID	Street name or property name
Tree Number	Count starts at 1 for each street/site. Unique to tree
Species	Common name. Include in comments box if not listed
Tree Condition	• *Good:* full canopy (75-100%), no dieback of branches over 2" in diameter, no significant defects, minimal mechanical damage • *Fair:* thinning canopy (50-75%), medium to low new growth, significant mechanical damage, obvious defects/insects/disease, foliage off-color and/or sparse • *Poor:* declining (25-50%), visible dead branches over 2" in diameter, significant dieback, severe mechanical damage or decay (over 40% of stem affected) • *Dead:* no signs of life, bark peeling; scratch test on twigs for signs of life (green) • *Vacant:* potential spot for a tree within the public ROW. Add "small", "medium", or "large" in the comments box - Small= max 30' at maturity, presence of overhead wires, minimum planting space 4' x 4' -Medium= 30-50' at maturity, green belts over 6' wide, no overhead wires - Large= 50'+ at maturity, parks and open space
Diameter (DBH)	Diameter taken at 4.5' above ground in classes of 0-3", 3-6", 6-12", 12-18", 18-24", 24-36", 36-42", 42"+. If on slope, uphill side measured. If abnormal growth, measured above or below growth. If multi-stemmed, each stem's DBH is squared, all squares summed, and the square root taken; indicate "multi-stemmed" in comments box.
Consult	• *Yes:* any one defect is affecting >40% of the tree, posing a hazard to people/infrastructure/cars, growing into utility wires, dead or poor condition, ash tree showing evidence of woodpecker flecking, blonding, epicormic branching/water sprouts, and/or suspicious exit holes • *No:* no major defects, tree in good or fair condition
Comments	Notes, elaborate on any existing conditions; max 255 characters
House Number	Corresponding house address, numerical field. If a corner lot house is on a different street, enter house number and write "House located on X Street; corner tree" in comments box

Collection Date/Time	Date and time
Photo	Photo of full tree. Additional photos of any significant defects

Left: Prior to each inventory, VT UCF staff and interns met to discuss and plan the most effective routes for data collection using a large parcel map.
Right: An example of a photograph of an individual tree that is attached to the record in the "Collector" application.

The data were compiled and subsequently analyzed and summarized using Microsoft Excel and ArcGIS. Data were also uploaded to i-Tree Streets in order to determine the monetary and ecological benefits of Johnson Village's inventoried public trees. A baseline assessment of the Village's full tree canopy coverage, encompassing both private and public property, was conducted using i-Tree Canopy. i-Tree is a free software suite developed by the USDA Forest Service and is available at www.itreetools.org.

Inventory Results

Urban Forest Diversity

Of the 363 trees inventoried within the public ROW or on town-owned land, there were a total of 45 different species in 22 different genera. The most common tree genera: *Acer* (maple), *Pinus* (pine), *Betula* (birch), *Fraxinus* (ash), and *Malus* (apple), comprise about 70% of Johnson Village's urban forest. *Picea* (spruce), *Quercus* (oak), *Syringa* (lilac), *Thuja* (cedar), and *Ulmus* (elm) comprise about 18% of the Village's urban forest. The ten most common genera represent 88% of Johnson Village's urban forest (Figure 1). Four *Acer* species are among the ten most common tree species inventoried in Johnson Village (Figure 2). *Acer saccharum* (sugar maple) (19.01%) is the most common species in the Village followed by *Pinus strobus* (eastern white pine) (14.33%) and species within the *Betula* (river and paper birch) (8.26%) genus, *Acer negundo* (boxelder) (5.79%), and *Acer rubrum* (red maple) (5.23%) (Figure 2). A complete species and genera list can be found in Appendix B.

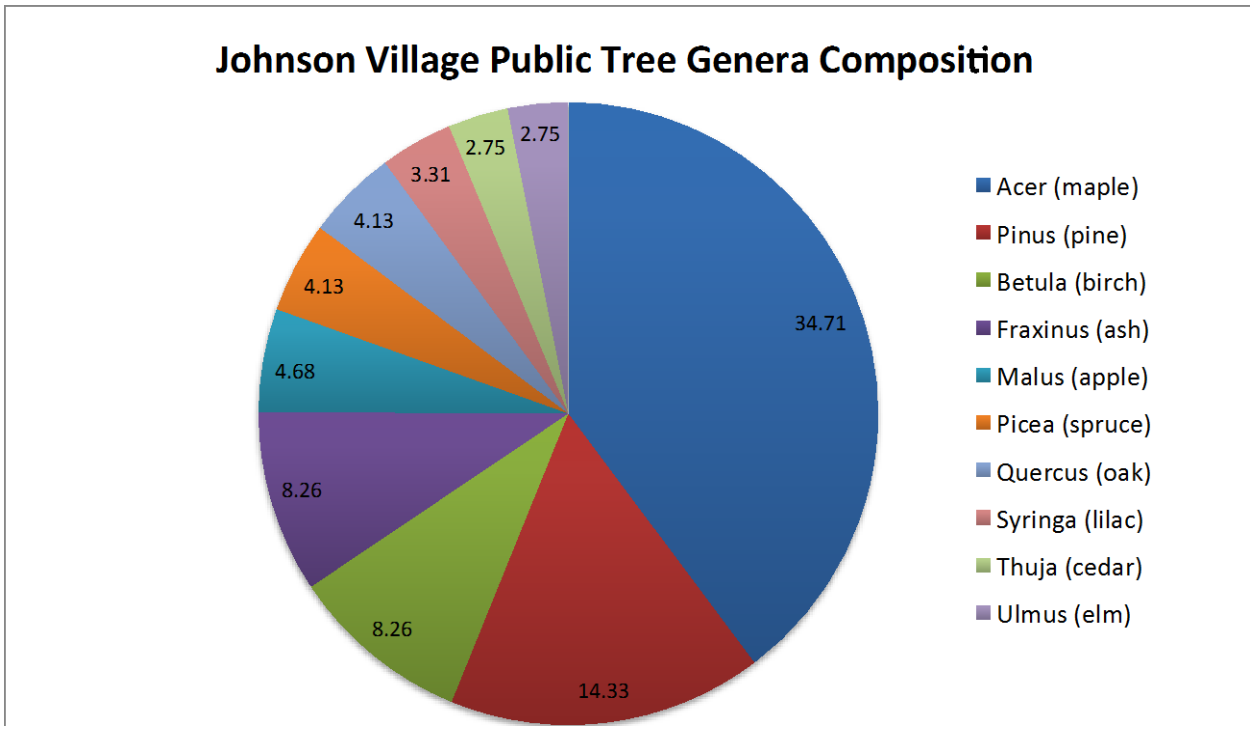


Figure 1: Most common tree genus by percent composition in Johnson Village, VT.

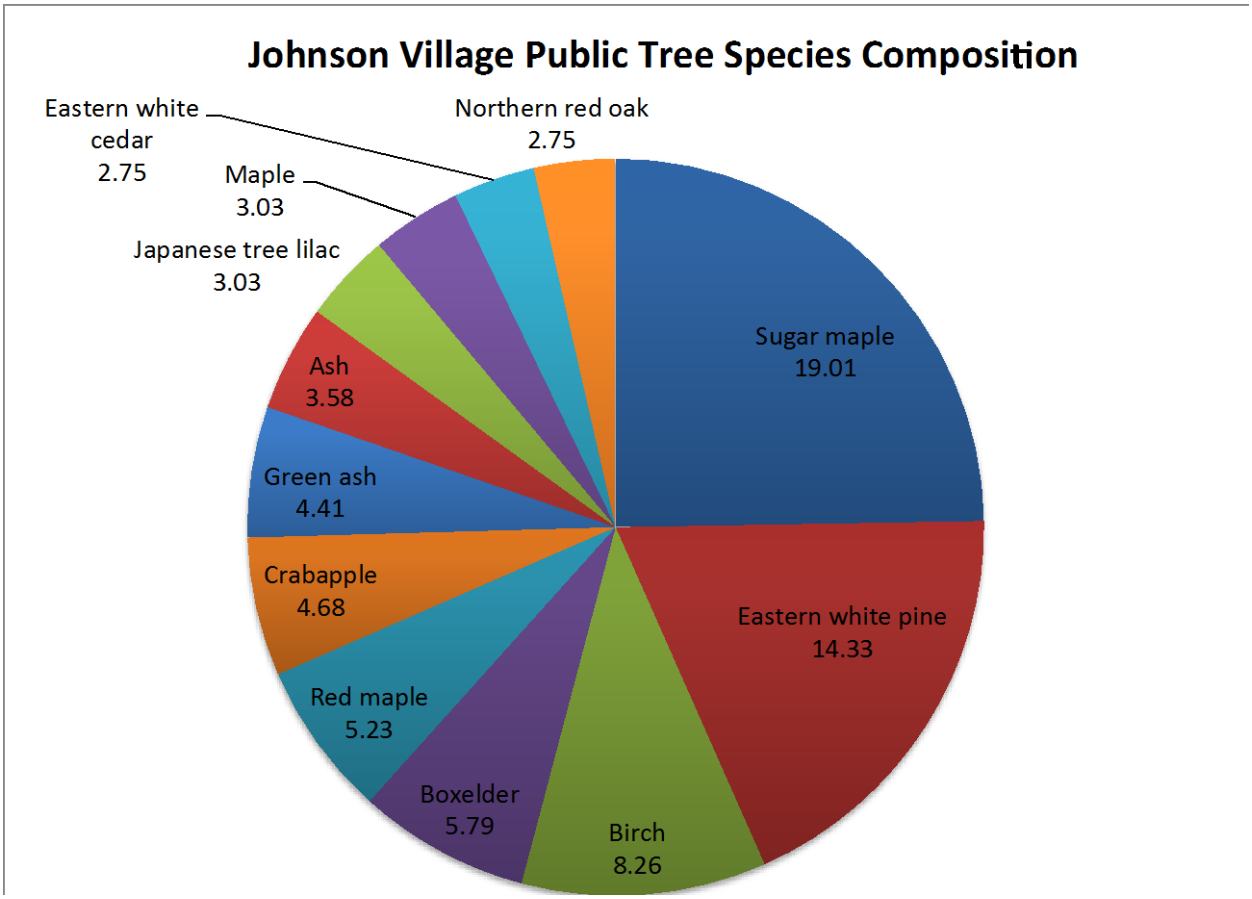


Figure 2: Most common tree species by percent composition in Johnson Village, VT.

Urban Forest Structure

Most of Johnson Village's inventoried trees (95 trees or 26.17%) have a diameter at breast height (DBH) between six and twelve inches (Figure 3). Nearly 20% of the inventoried trees (67 trees) are assumed to be relatively young based on their small diameter class (0-3"). Tree abundance within the three to six inch (15.43%) and the twelve to eighteen (16.80%) inch diameter classes are nearly equally distributed, while the remaining 23.14% of inventoried trees had a DBH greater than eighteen inches (Figure 3). Assuming that public street tree diameter size class correlates to tree age, much of the Johnson Village urban forest is either relatively young, or approaching their mature size (Figure 4).

The composition of genera and species within each of these size classes (Figures 5 and 6) provides insight into Johnson Village's land-use history, while also informing the development of the Village's urban forest management plan. *Acer* and *Pinus* are the only

genera with DBHs 24 inches or greater (Figure 5). This is not only likely due to the longevity associated with these genera, but also to their population abundance. Few to no trees in the *Pinus* genus have small DBHs (0-3" or 3-6" respectively) (Figure 5). This is indicative of the now uncommon planting practices of the *Pinus* genus within the public ROW. Most trees (35) in the small size classes are within the *Acer* (maple) genus. *Fraxinus* (ash) and *Betula* (birch) species have the second greatest abundance in small size and young age classes with 15 and 11 trees, respectively (Figure 5). This age distribution is of particular importance, as the two genera dominating Johnson Village's forest over time are at risk of future pest invasion. It is therefore recommended that Johnson Village officials diversify the younger tree population.

The species and genera diversity decreases in size classes 18 inches and greater (Figure 5 and 6). The three largest size classes, 30-36", 36-42", and >42", contain a total of 12 trees. These trees are growing within the public ROW or on town-owned land and were probably not planted as street trees but left as remnants as the town grew. The two largest trees inventoried were an *Acer saccharinum* (silver maple) in poor condition on Pearl Street and a *Thuja occidentalis* (eastern white cedar) in good condition in Lamoille View Cemetery.

Twenty "vacant" potential tree planting locations or swaths of land were identified within the public ROW. It is important to note, however, that large swaths of land where many trees could be planted, such as at Old Mill Park, were only plotted as one point and estimates for how many trees could be planted around that point were detailed in the Description field. Potential tree planting locations by street and site are presented in Appendix A. With 21 potential planting locations (represented by 5 plotted points), Old Mill Park has the greatest potential for tree planting within Johnson Village's public land. Katy Win Road E has 11 potential planting locations within the public ROW. Of the 20 inventoried vacant locations, 17 were identified as appropriate for a large tree, 1 would be appropriate for a medium or large tree, and 2 are suitable for a small tree.

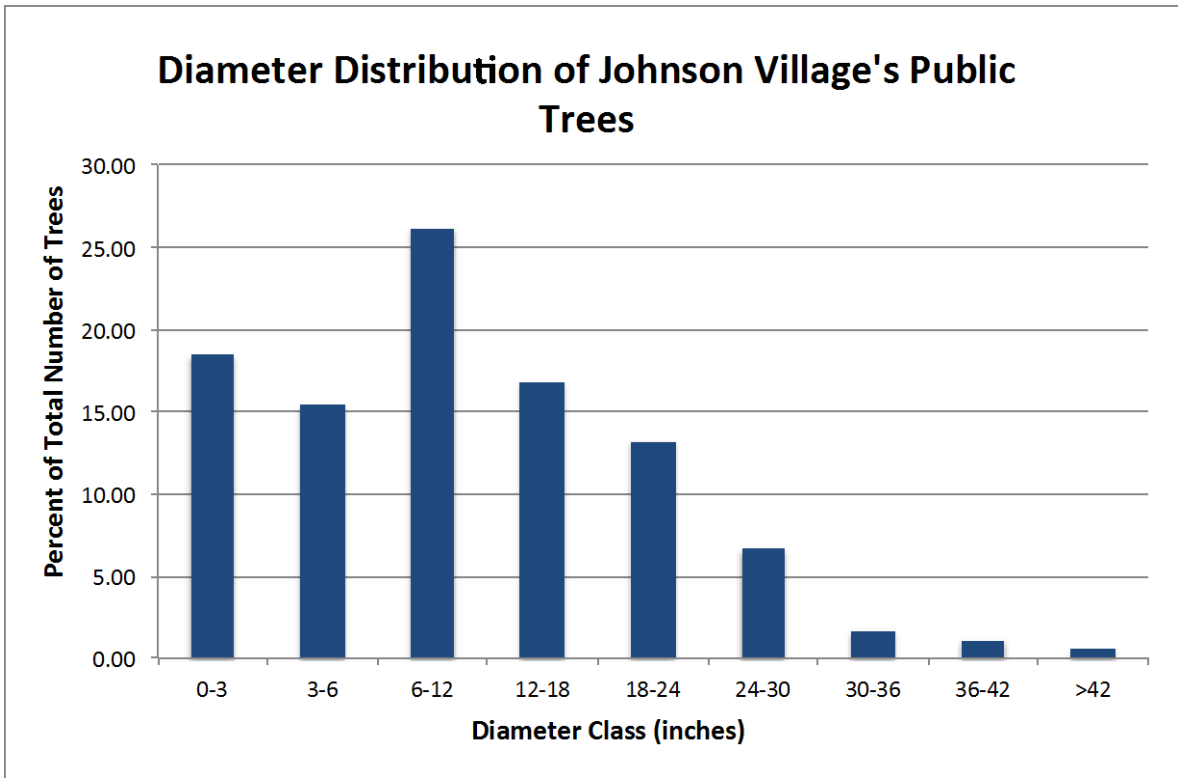


Figure 3: Percentage of trees within each diameter class (inches) in Johnson Village, VT.

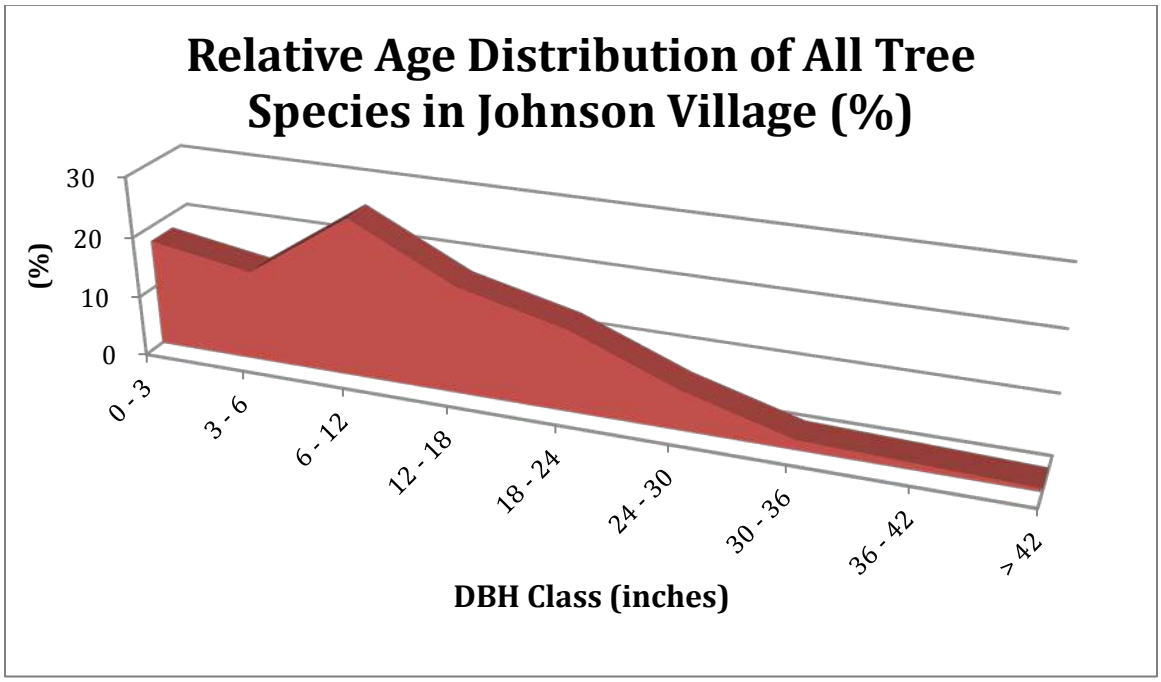


Figure 4. Percent relative age distribution of all species inventoried in Johnson Village, VT.

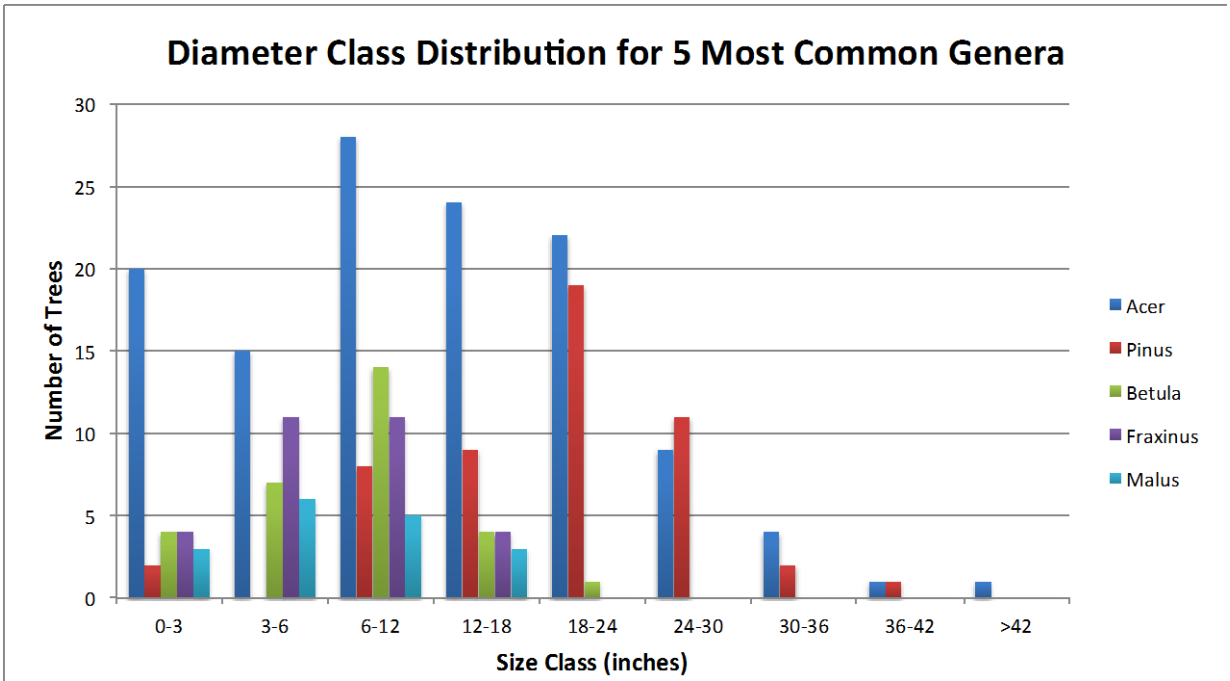


Figure 5: Diameter (inches) distribution for the five most common genera in the Johnson Village urban forest.

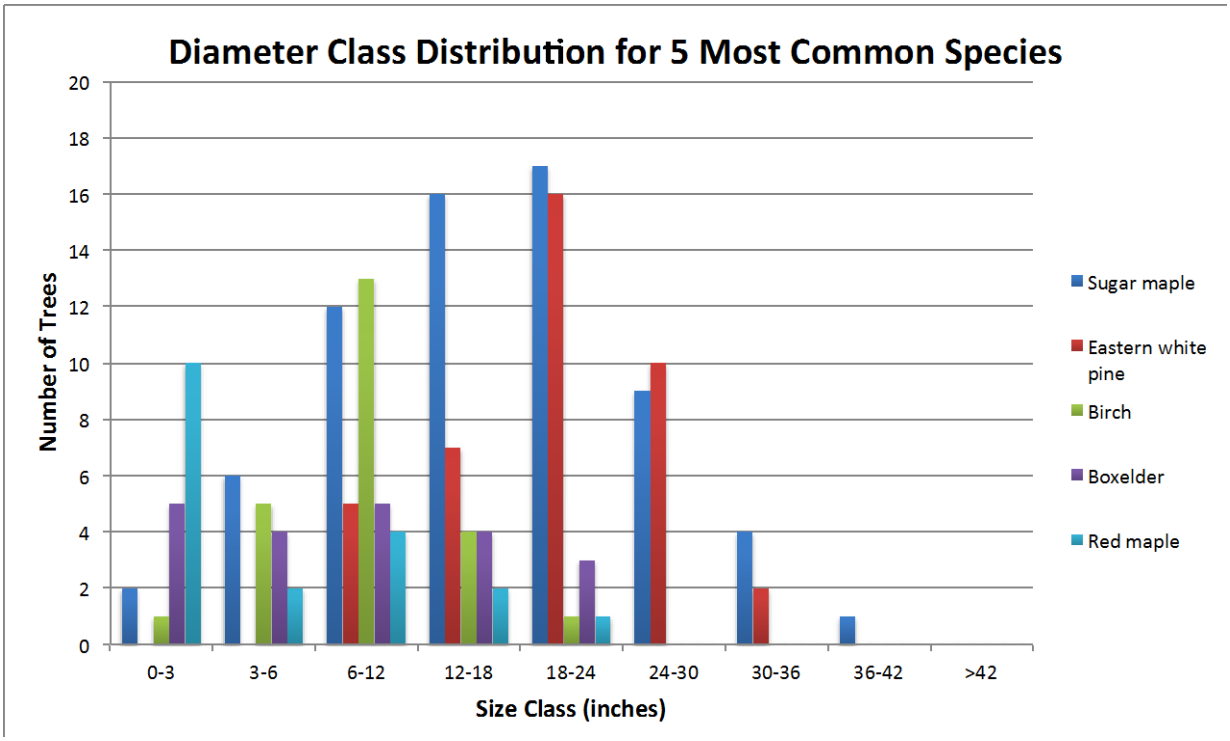


Figure 6: Diameter (inches) distribution for the five most common species in the Johnson Village urban forest.

Urban Forest Health

The majority (73.13%) of Johnson Village's inventoried public trees were assessed as being in "good" condition; of the remaining trees, 47 were considered in "fair" condition, 29 were in "poor" condition, and 7 were "dead" (Figure 7). Only one of the seven dead trees, an *Acer saccharum* (sugar maple), is within the five most common genera (Figure 8). Four of the remaining six dead trees are *Ulmus americana* (American elm), and two were unidentifiable species. The genera *Acer* has the most trees in each condition class (Figure 8), which is likely because it comprises the highest percentage of all inventoried trees. Most of the species within the *Fraxinus* (ash) genera are in "good" condition, and are important to monitor if or when EAB is detected in VT.

Fifty-one trees (14.04%) were identified as in need of consult during the inventory. The Johnson Tree Warden or a certified arborist should reassess each of these trees within a timely matter. Trees that were flagged for a consult expressed one or more of the following conditions:

- The tree had a defect affecting >40% of the tree,
- The tree posed a hazard to people, infrastructure, and/or cars,
- The tree was growing into utility wires, or
- The tree was dead, in decline or in poor condition.

Although three *Fraxinus pennsylvanica* (green ash) were flagged as in need of consult, none of the comments indicated evidence of EAB signs or symptoms.

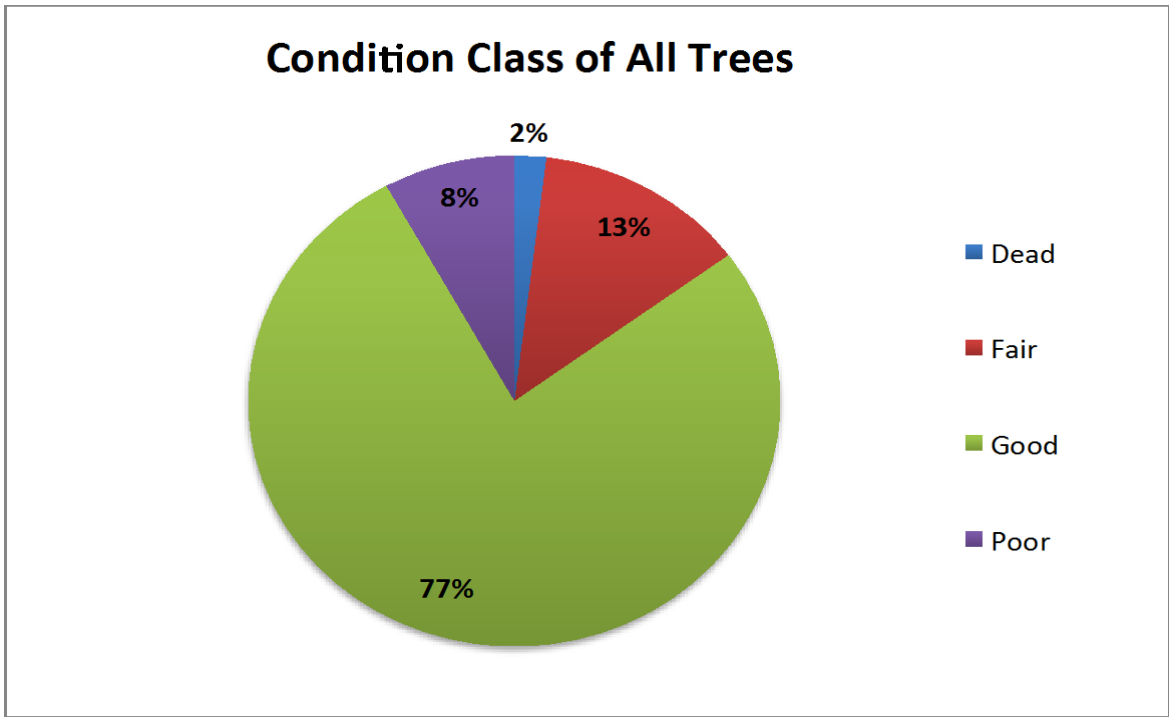


Figure 7: Percentage of Johnson Village's inventoried trees in each condition class.

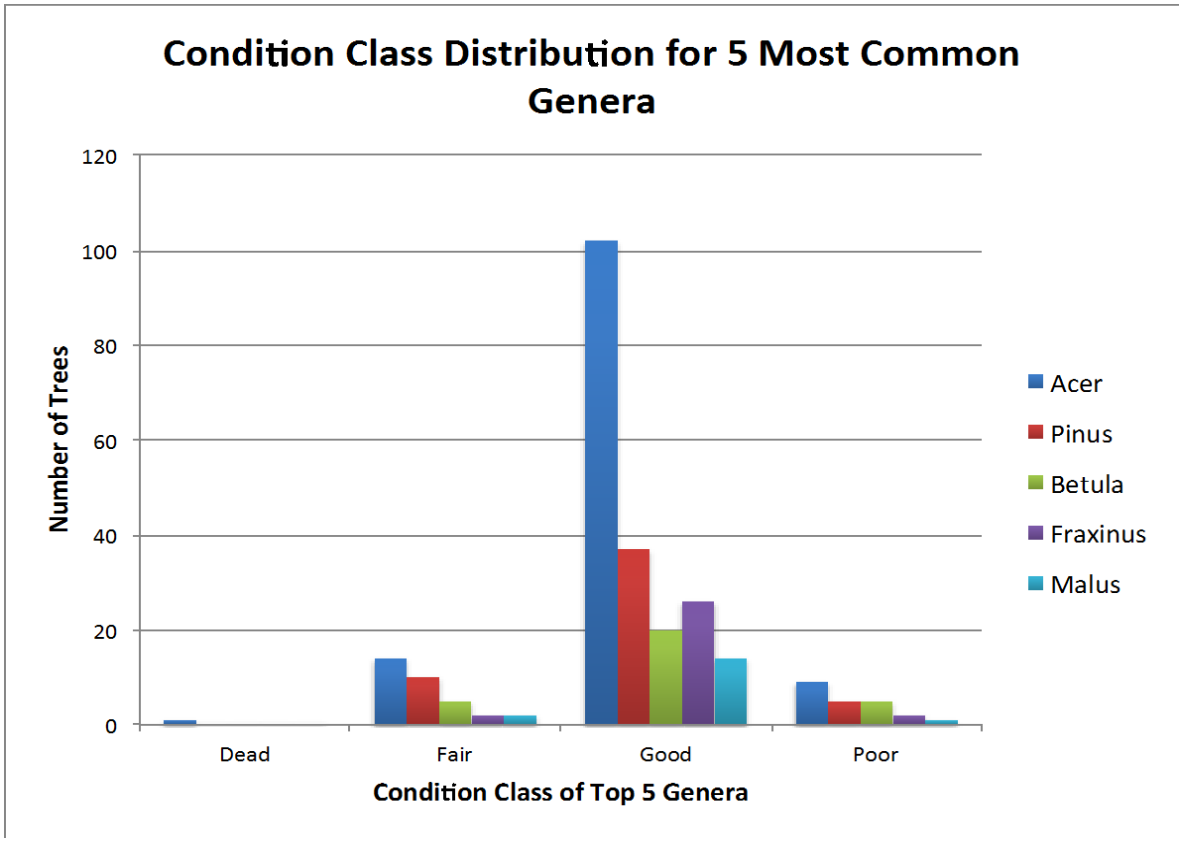


Figure 8: The number of trees within the five most common genera displayed according to condition.

Monetary Value and Ecosystem Services: i-Tree Streets

Johnson Village's inventory data was analyzed using i-Tree Streets software to determine the monetary value of the ecosystem services provided by the community's trees. i-Tree streets assesses the total annual monetary value of inventoried public trees and the average monetary value per inventoried public tree based on the ecological and societal benefits described in Table 2. It is important to note that unlike i-Tree Canopy's analyses, i-Tree Streets' are specific to Johnson Village's 363 inventoried public trees. The 363 trees provide a total of $29,003.00 in annual benefits by filtering air pollutants, mitigating stormwater runoff, sequestering carbon dioxide (CO_2), conserving energy, and increasing property values (Figure 9). On average, each Johnson Village public tree offers approximately $80 annually in savings or ecosystem services.

It is important to recognize that the trees inventoried through this project were located within the public ROW of Johnson Village (a 1.2 square mile area). Expanding the inventory to the town of Johnson would increase these figures dramatically. It is also noteworthy that larger and long-lived trees provide substantially more benefits than young, small trees; regular maintenance and care are needed to provide for urban tree health, longevity, and maximized urban forest benefits.

Figures 9 and 10, and Table 2 provide an overview of each ecosystem service provided by Johnson Village's public trees. In terms of their monetary value, energy conservation and property value increase are the most significant services provided by these trees. It is important to note, however, that even some of the lesser monetarily valued tree benefits in Johnson Village are still important. The Lamoille River runs through Johnson Village. The presence of this water body warrants particular interest in the stormwater runoff benefits provided by the Village's trees. Although the annual monetary value of Johnson Village's trees for stormwater runoff is $3,669 (Figure 9 & Table 2), the trees intercept approximately 458,678 gallons of rainfall a year. This is a considerable ecosystem service, as Johnson Village's green infrastructure works to maintain the integrity of the Lamoille River in Johnson Village and downstream. To date, Johnson Village's public trees have stored about 992,015 pounds of carbon. Although individuals often overlook this

ecosystem service, trees mitigate the effects of climate change by storing atmospheric carbon. The older and larger a tree gets, its potential to store carbon increases. Based on the Village trees' age distribution (Figure 4), it is likely that this urban forest will store greater amounts of carbon over time, providing a significant ecosystem service. The full reports produced through the i-Tree Streets program for Johnson Village will be given to the Johnson Tree Board.

Figure 9: Summary of benefits provided by Johnson Village's public trees, as reported through the i-Tree Streets assessment.

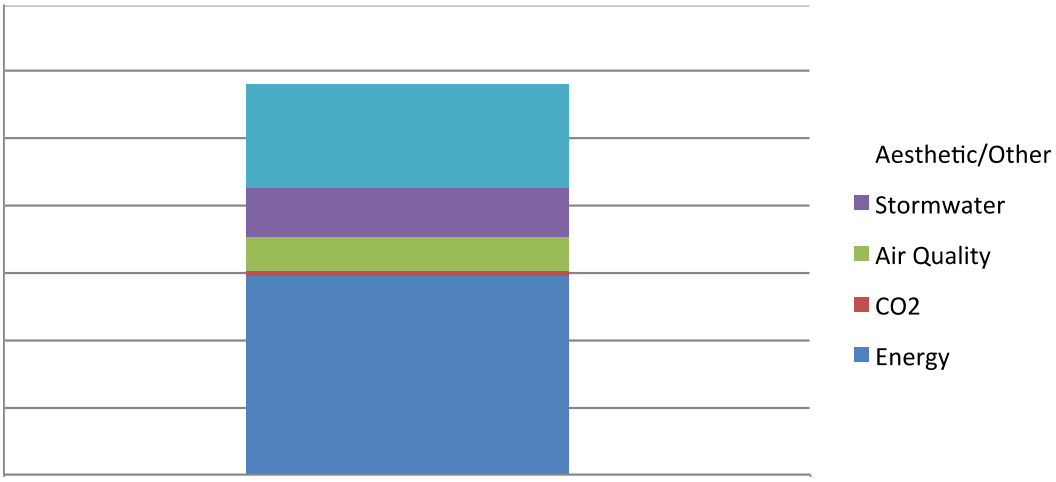


Figure 10. The total annual monetary benefits of public trees in Johnson Village, VT, as reported in the i-Tree Streets assessment.

Table 2: Annual environmental and monetary benefits provided by Johnson Village's public trees, as reported in the i-Tree Streets assessment.

Benefit Type	**Benefit Description**	**Total Annual Value of Inventoried Trees**	**Average value/tree**
Energy conservation	Reduced natural gas use in winter and reduced electricity use for air conditioning in summer	$14, 816	$40.93
Carbon dioxide	Annual reductions in atmospheric CO2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use. The model accounts for CO2 released as trees die and decompose and CO2 released during the care and maintenance of trees.	$311	$0.86
Air quality	Quantifies the air pollutants (O3, NO2, SO2, PM10) deposited on tree surfaces and reduced emissions from power plants (NO2, PM10, VOCs, SO2) due to reduced electricity	$2,616	$7.23

	use. Also reported are the potential negative effects of trees on air quality due to BVOC emissions.		
Stormwater	Reductions in annual stormwater run-off due to rainfall interception by trees.	$3,669	$2.58
Aesthetic/other	Tangible and intangible benefits of trees reflected in increases in property values.	$7,591	$5.35
Stored carbon dioxide	Tallies all of the carbon dioxide stored in the urban forest over the life of the trees as a result of sequestration. *Not an annual benefit but a cumulative benefit.	$3,274*	$9.04*
Totals		**$32,277 cumulative*, $29,003 annual**	**$88.92 cumulative*, $79.89 annual**

Johnson Village Full Canopy Assessment: i-Tree Canopy

As a complement to the public tree inventory, VT UCF staff completed an i-Tree Canopy assessment for the inventoried area in Johnson Village, encompassing both public and private land. i-Tree canopy is a free, easy-to-use online application that allows users to assess total tree cover over an area based on randomly- generated map points and user-defined land cover types. The tool also assigns dollar values to the benefits associated with the overall tree canopy cover. The aim of this type of assessment is to help citizens and decision-makers better understand the existing and potential tree canopy in their community.

Based on the Johnson Village i-Tree Canopy assessment, approximately 50% of the Village is currently occupied by tree canopy (Figure 11). In consideration of the other land cover types present; Johnson Village could potentially increase its total tree canopy cover by an additional 29% on open lands of low-lying vegetation, 4% on agricultural land, and by 12% with strategic planning around or within impervious surface areas (parking lots, playgrounds, roads and the ROW) (Figure 11). Buildings or water occupy 5% of Johnson

Village's land area and are unsuitable for tree planting. In total, there is currently potential to increase overall tree canopy cover in Johnson Village by 45% (Figure 12).

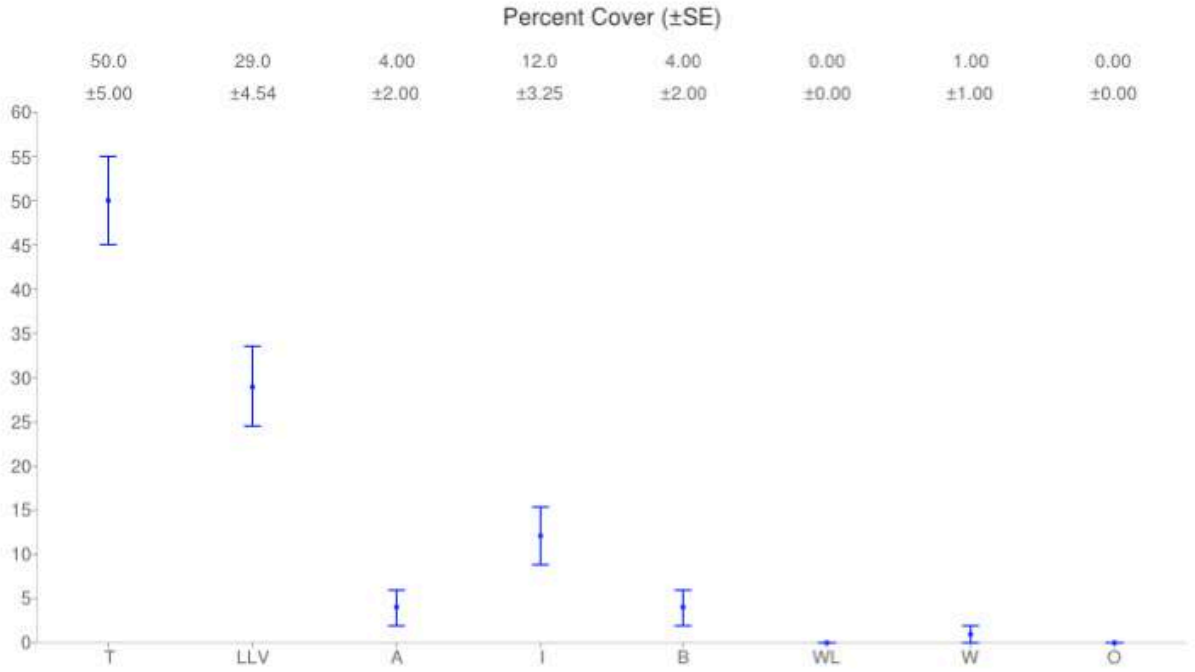
Figure 13 compliments the i-Tree Streets analysis of the monetary value of benefits provided by Johnson Village's public trees by estimating the air quality benefits and corresponding monetary value for the full urban forest canopy. Of note is an estimated $434,778 in CO_2 storage and $17,244 in annual CO_2 sequestration value.

The i-Tree Canopy assessment was performed within the confines of Johnson Village's 1.2 square mile area. Expanding the public tree inventory outside of Johnson Village's borders to the Town of Johnson would alter the i-Tree Canopy results discussed above and displayed below. Regular maintenance and care of existing trees and strategic future plantings are needed to ensure urban tree health, longevity, and maximized urban canopy cover benefits.

i-Tree Canopy v6.1

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 9/23/14



Cover Class	Description	Abbr.	Points	% Cover
Tree	Tree, non-shrub	T	50	50.0 ±5.00
Low-lying Vegetation		LLV	29	29.0 ±4.54
Agriculture		A	4	4.00 ±2.00
Impervious	parking lots, streets	I	12	12.0 ±3.25
Building		B	4	4.00 ±2.00
Wetland		WL	0	0.00 ±0.00
Water		W	1	1.00 ±1.00
Other	Sand cover, quarries, swimming pool, etc.	O	0	0.00 ±0.00

Figure 11: i-Tree Canopy assessment for Johnson Village, VT.

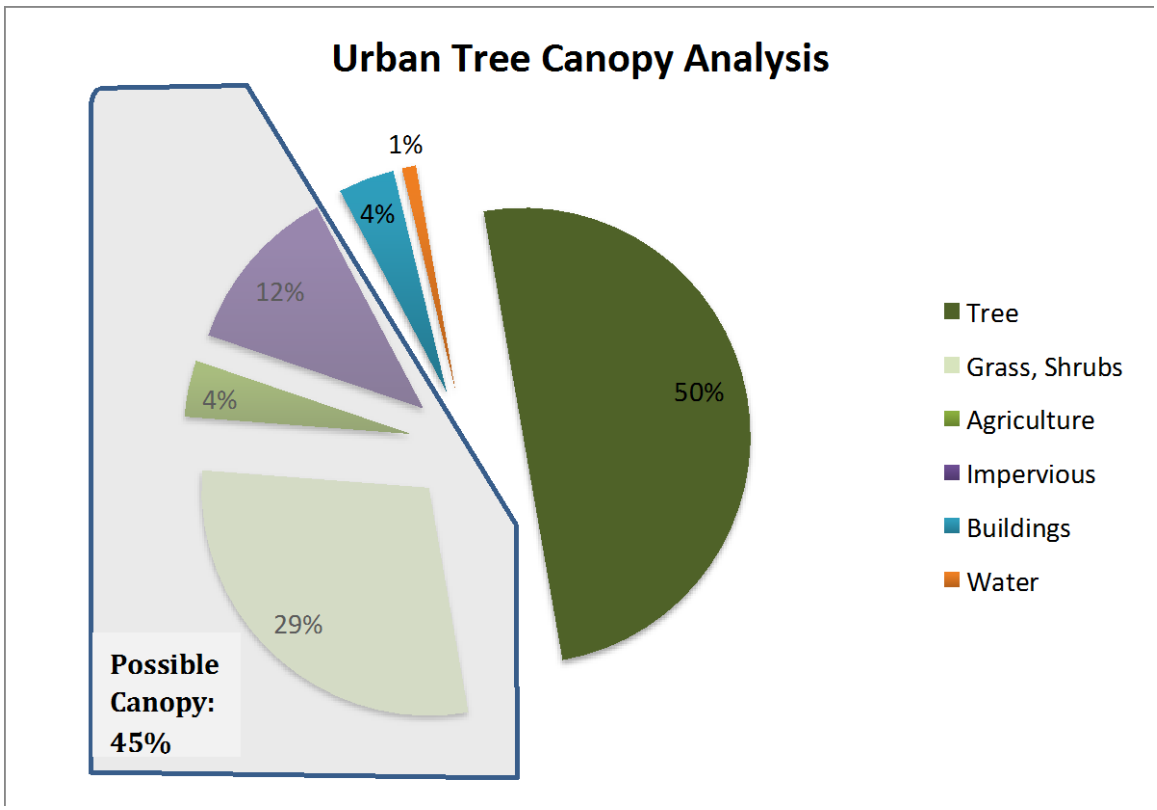


Figure 12: Johnson Village's urban tree canopy analysis.

Tree Benefit Estimates

Abbr.	Benefit Description	Value	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	$17.21	±1.72	405.94 lb	±40.59
NO2	Nitrogen Dioxide removed annually	$29.63	±2.96	1.11 T	±0.11
O3	Ozone removed annually	$1,542.85	±154.28	11.02 T	±1.10
PM2.5	Particulate Matter less than 2.5 microns removed annually	$3,189.35	±318.94	1,071.23 lb	±107.12
SO2	Sulfur Dioxide removed annually	$5.18	±0.52	1,394.89 lb	±139.49
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	$1,120.07	±112.01	3.69 T	±0.37
CO2seq	Carbon Dioxide sequestered annually in trees	$43,459.39	±4,345.94	2,244.42 T	±224.44
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	$1,095,746.57	±109,574.66	56,588.73 T	±5,658.87

Figure 13: i-Tree Canopy assessment estimates for air quality benefits of Johnson Village's full canopy (public and private trees).

Discussion and Recommendations

Urban Forest Diversity and Structure

An important best management practice in urban forestry is to maintain a diverse range of species and age classes. Communities should work to maintain an urban forest with no more than 20% representation of a single genus (for example: maples) and no more than 10% of one species (for example: sugar maple). A diverse genus and species composition is an imperative component to a healthy community forest. A diverse forest is more resistant to disease and insect infestation, which pose greater threats to our trees each year. A more diverse forest is more resistant to environmental stressors, and therefore likely to remain healthy and resilient in the face of change. Maintaining a higher diversity within a community forest further prevents rapid canopy loss from insects and disease and reduces long-term costs associated with tree maintenance.

In Johnson Village, about 35% of inventoried public trees were in the *Acer* (maple) genus, which is 15% over the recommended genus representation within a community's urban forest. Specifically, sugar maple, boxelder, red maple, and Norway maple represent about 19%, 6%, 5%, and 1% of the species diversity respectively (3% of *Acers*

Components for Managing a Vibrant and Resilient Urban Forest

A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations. We recommend the following components for successful urban forest management.

Public Policies: A tree ordinance or policy provides authority for conducting forestry programs, defining municipal responsibility for public and private trees, passing regulations and setting minimum standards for urban forestry management.

Leadership: Define who is responsible for the oversight of the community forest, including formulating policies, advising, administration, management, representation and/or advocacy.

Partnerships: A well-managed urban forest takes the work of many. Seek strategic partnership to meet a shared vision. At a minimum the tree warden, a local advisory committee like a tree board or conservation commission and municipal staff (parks, roads, planning) should collaborate.

Responsibility: A clear understanding of which trees and areas will be managed is an important first step. Street trees, parks and village greens, cemeteries and schools are typical areas of municipal responsibility.

Assessment: A complete public tree inventory, including tree locations, species, condition, and management needs provides the necessary information to manage the resource. An inventory is the foundation to developing a strategic management plan.

Management Plan: A management plan provides a vision for the long-term management of the community forest. It should include strategies, budgets, and responsibilities for meeting that vision.

Staffing: The care of urban forest requires a certain skill set that can be found in-house with professional staff or through consultants. Whether creating a staff position for a certified arborist or urban forester, or contracting with them on an as-needed basis, professional assistance will have some of the greatest and most immediate impacts on a community forestry program.

Tree Canopy Goals: Consider a community's entire tree canopy to reduce loss and maximize gains over time by protecting undeveloped forest and impacts of land development, enhance the health condition and function of forests, and reforest through active replanting or allowing regeneration.

inventoried did not have a species specified). Sugar maple is the most prevalent species in Johnson Village, and comprises nearly double of the recommended 10% species composition for a community forest. Although sugar maples are culturally and aesthetically pleasing, it is recommended that Johnson Village avoid planting more sugar maples and prioritize the planting of non *Acer* tree species. The *Pinus* genus comprises about 14% of Johnson Village's forest, with eastern white pine being the only *Pinus* species present. Eastern white pine's population in the Village's forest is nearly 5% over the recommended species composition. Ash trees (genus *Fraxinus*) make up 8% of the public tree canopy of Johnson Village. Invasive tree pests currently threaten both ash (the emerald ash borer) and maple trees (Asian longhorned beetle). While neither of these pests have been discovered in Vermont, the risk of their introduction becomes greater each year. The largest ALB infestation in North America is about 50 miles south of Vermont in Worcester, MA. This, in addition to the discovery of EAB in New Hampshire in 2013, indicates Vermont is nearly surrounded by states or provinces with isolated infestations of invasive and detrimental pests.

Recommendation:

Develop species, structural, and age diversity by planting new species and increasing the number of lesser represented species using best management practices in order to promote long-term health and resilience of individual trees and Johnson Village's urban forest.

Recommended action practices:

- We advise against planting high-density stands of the same species (monocultures) whose close proximity may be conducive to the spreading of disease.
    - We specifically recommend Johnson Village officials avoid planting the genera and species that currently comprise a greater percentage of the community forest than recommended.
- We suggest planting tree species that have been grown successfully in the area that do not show any signs of diseases and deformity, and that are not non-native invasive species (specifically Norway maple).

- Existing ash trees should be regularly monitored for signs of EAB, and Johnson should avoid planting any more ash trees. The Johnson EAB Preparedness Plan should also be followed and all members of the Johnson Tree Board should be familiar with the document.
- Encourage Johnson Village citizens to participate in the Vermont Forest Pest First Detector Training to expand local capacity to identify and monitor for invasive forest pests.
- In order to diversify both species composition and age structure, refer to the 20 identified vacant planting locations and/or strips and develop a strategic planting plan.
- In planning for future tree plantings, consider obstructions above ground (power lines) and below ground, minimize grey infrastructure conflicts (sidewalks, streets, buildings, etc.) available soil volume, species mature size (height and spread), branching patterns, environmental tolerances (exposure, salt, and drought), and desired function when choosing species. For more information on site assessment and species selection, refer to the VT Tree Selection Guide at http://www.vtcommunityforestry.org/resources/tree-selection.
- Encourage residents to plant trees on their properties to increase species diversity, age structure, and overall tree canopy benefits to the community.

Maintenance

Proper tree maintenance, especially pruning, can extend the life and health of trees, as well as reduce public safety issues. There are four main pruning practices of note:

- Crown cleaning: removes dead, diseased, and damaged limbs
- Crown thinning: selective removal of stems and branches to increase light penetration and air movement throughout the crown of a tree
- Crown raising: the removal of lower branches over 2 inches in diameter to provide clearance for pedestrians and vehicles
- Crown reduction: removing individual limbs from structures or utility wires

Proper and regular mulching for soil health, moisture retention, and protection from mechanical damage is also encouraged. Finally, an irrigation regime should be in place for newly planted trees to ensure proper establishment and tree root regeneration.

Recommendation:

Establish a routine maintenance cycle, implemented by trained professionals and overseen by the Johnson Tree Board, for all public trees to promote tree health and reduce any threat to public safety.

Recommended action practices:

- Complete a full inventory of all public trees in Johnson (beyond the Village) in order to establish a routine maintenance regime for all town-managed trees.
- Work with VT UCF to ensure municipal tree maintenance staff is trained in best management practices.
- Establish a systematic pruning cycle to reduce branch and tree failures due to poor structure, minimize conflicts with people and infrastructure, improve line of sight, and reduce storm damage. When trees are located near electrical utility lines, it is important to work directly with the local utility company.
- Encourage Johnson citizens to participate in VT UCF's Stewardship of the Urban Landscape training course to continue to build local capacity to care for and promote Johnson's canopy.

Urban Forest Health

With 77% of its public trees in good condition, Johnson Village appears to have a healthy community forest. Approximately 28% (87) of Johnson Village's public trees were either considered to be in "fair" or "poor" condition, or "dead". Only seven public trees were classified as dead, all of which should be consulted for potential removal. Concentrations of fair, poor, and dead trees were mostly found on Gould Hill Road, Clark Avenue, Lower Main Street (E and W), Katy Win E, and Crabtree Lane. Fifty-three trees were flagged for consult, and should be revisited by the Johnson Tree Warden or a certified arborist; many of these trees overlap those designated to be in poor condition or dead, but others were likely noted

because of conflict with utility wires or other infrastructure. See Appendix C for a map detailing the locations of the fair, poor, and dead trees in Johnson Village and a map indicating the location of the 53 trees requiring a consult.

Low soil volume and fertility, exposure to salt spray, root damage, mechanical damage to the stem, poor pruning, and improper planting are some of the contributing factors that may lead to decreased tree health in an urban setting. Most, if not all, of these factors can be avoided by proper planting and tree maintenance.

Recommendation:

Continue to monitor trees in good and fair condition, plan to lose trees in poor condition, and remove dead trees to increase overall urban forest health.

Recommended action practices:

- Visit and assess the 53 trees flagged for consultation in a systematic and timely fashion.
- Remove the 7 public trees identified as dead.
- Closely monitor the health of the 29 public trees in poor condition and plan for their removal and replacement in the near future. Assess the soil, and determine whether or not these newly vacant locations are suitable for replanting.
- Continue to monitor the health of the trees in good and fair condition and record any changes in tree health.
- Prioritize efforts on identified streets with the highest concentrations of fair, poor and dead trees.

Assessment Tools

Using free i-Tree software developed by the USDA Forest Service, we were able to assess the value and potential expansion of Johnson Village's urban tree canopy. i-Tree Streets allowed us to determine the economic value of the ecosystem services provided by the 363 inventoried public trees in Johnson Village. The Village's public trees generate about $29,003 annually through the benefits of air quality improvement, electricity and natural gas, aesthetics, and stormwater control; on average, each tree offers about $80 in service or

savings every year. Johnson Village's 363 inventoried public trees also have a cumulative monetary benefit of $3,274 in stored carbon dioxide. The trees of Johnson Village provide services to the town in the following ways:

- **Aesthetics**: Urban trees can make an urban or suburban environment a more pleasant and satisfying place to live, work, and spend leisure time (Dwyer et al. 1991). In monetary terms, presence of shade trees can significantly increase property values. There are also numerous health benefits to trees. For example, hospital patients with window views of trees have been shown to recover faster than patients without such views (Ulrich 1984).
- **Air quality**: Trees improve air quality by removing air pollutants through their leaves, altering emissions from energy use, and by moderating air temperature.
- **Energy use**: Trees influence thermal comfort and energy use by providing shade, transpiring moisture, and reducing wind speeds. Over 100 million trees have been established around residences in the U.S. and it saves $2 billion annually in reduced energy costs (Akbari et al. 1988).
- **Stored Carbon Dioxide**: Urban trees can mitigate climate change by removing atmospheric carbon dioxide and storing carbon in their biomass. Urban trees also reduce emissions of nearby buildings by restricting energy needs and use. Urban trees in the contiguous United States store 770 million tons of carbon, which is valued at $14.4 billion (Nowak and Crane 2002).
- **Storm water run-off**: Trees and soil improve water quality and reduce costs associated with stormwater treatment by retaining or slowing flow of precipitation. Green infrastructure can filter precipitation, reducing the input of excess nutrients or pollutants in stormwater runoff.

Using a random sample method and based on assessing land cover types, i-Tree Canopy allowed us to measure the overall tree canopy cover within the boundaries of the inventory area, capturing both private and public tree canopy. Johnson Village has an impressive canopy cover of 50%. The Village's dominant land cover types, however, present the opportunity to increase its canopy cover by 45%. Johnson Village is encouraged to take the necessary steps to increase its canopy cover and associated benefits.

Recommendation:

Use the information generated through the i-Tree Streets and i-Tree Canopy programs to promote investment in urban forest management and local stewardship.

Recommended actions and practices:

- Use the i-Tree Canopy results in conjunction with the identified "vacant" locations to designate future planting areas. Prioritize land cover types with the greatest potential to increase Johnson Village's canopy by planting in areas of low-lying vegetation and impervious surfaces (parking lots and streets).
- Inform and promote urban forest stewardship by communicating the value and benefits (as provided by the i-tree Streets and Canopy assessments) of Johnson Village's urban forest to Village residents and municipalities. To improve outreach efforts, please see the 'How to View Data' section in Appendix C.

Conclusion

Trees in our urban landscapes contribute to environmental integrity, social cohesiveness, economic activity, cultural heritage, and enhance the quality of life for both humans and wildlife. This report is one component of a long-term effort by the Johnson Tree Board to understand, manage, and steward its urban forest. The recommendations outlined in this report are based on the VT UCF's interns' observations and data analysis combined with the experience and evaluation of VT UCF staff. The Johnson Tree Board should consider the recommendations presented in this report based on its long-term vision and current capacity.

Sources

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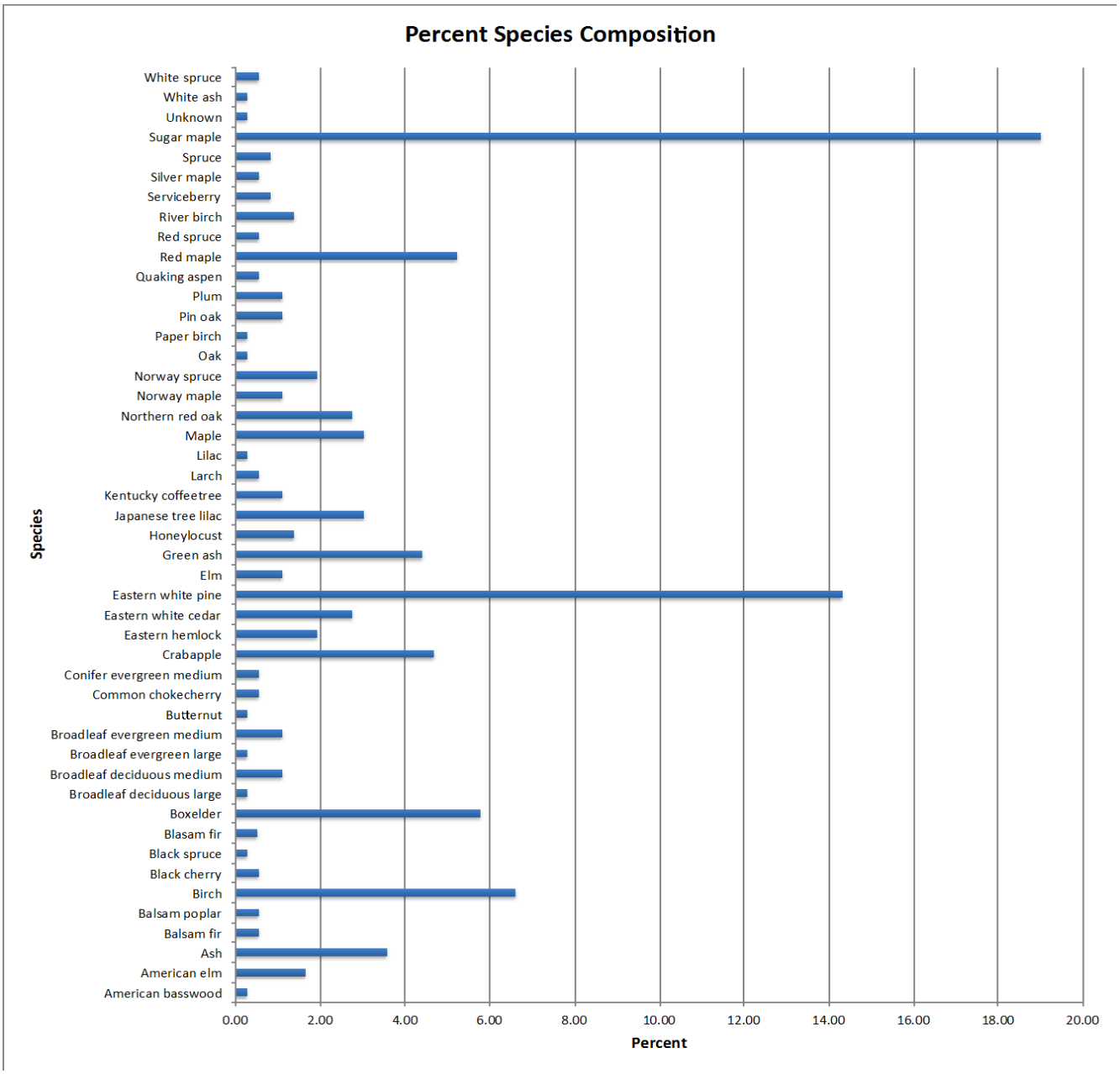
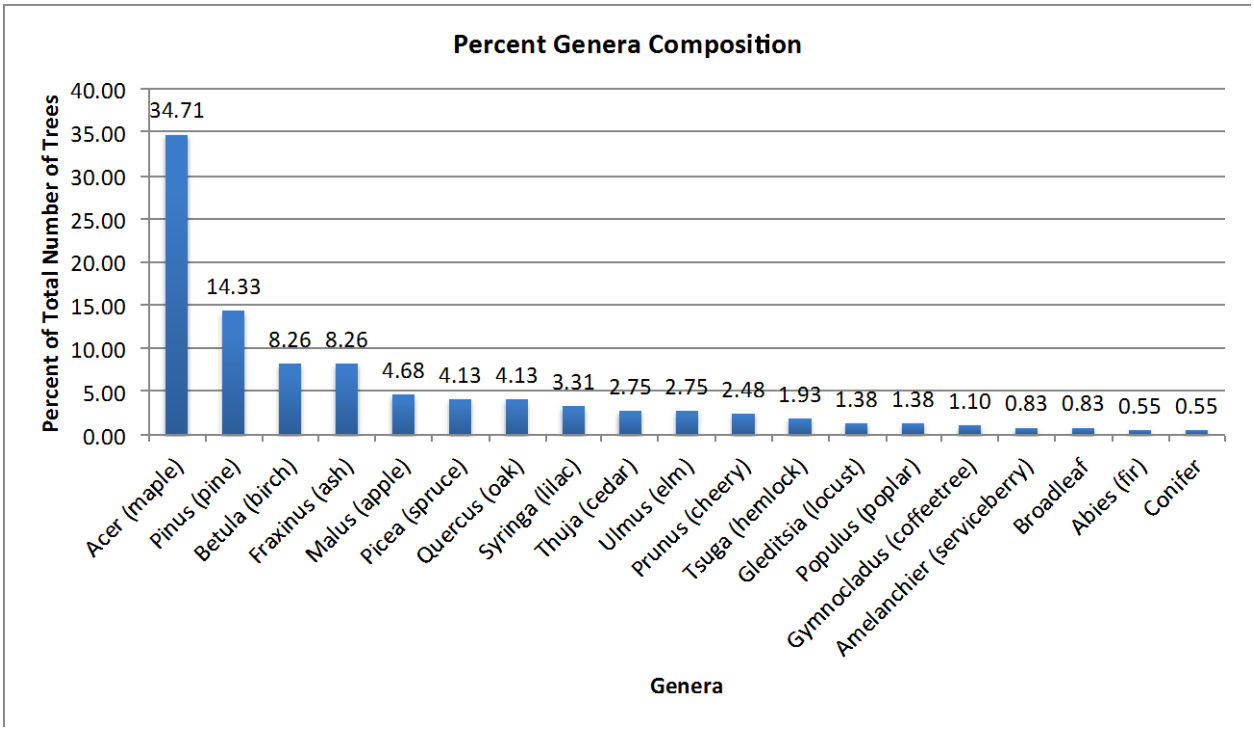
Appendix A: Full Street and Site List for the Johnson Village Inventory

Inventoried Streets	ROW Extent (feet)	Number of Inventoried Trees	Number of Vacant Spots or Strips
Adam Court	50	0	0
Basin Road	50	0	0
Barrows Drive	50	0	0
Clark Avenue	50	45	0
Clay Hill Road	50	8	0
College Hill Road	50	1	0
Collins Hill Road	50	0	0
Crabtree Lane	50	26	0
Creamery Street	50	3	0
Currier Drive	50	0	0
French Hill Road	50	0	0
George Hill Road	50	0	0
Gould Hill	50	43	0
Katy Win Road	50	18	11
Lamoille View Drive	50	20	0
Lendway Lane	50	0	0
Library Street	50	0	0
Lower Main Street (E & W)	100	32	2
Mack Mudgett Drive	50	0	0
McCuin Drive	50	3	0
Pearl Street	50	7	0
Pond Road	50	7	0
Railroad Street	50	17	0
River Road (E & W)	50	4	0
100C	100	0	0
Sargeant Drive	50	0	0
School Street	50	15	0
Sewer Plant Road	50	4	0
St. Johns Road	50	5	0
Still Road	50	2	0
Inventoried Sites	**Extent of Inventory**	**Number of Trees Inventoried**	**Number of Vacant Spots or Strips**
Duba Field	All landscape trees	0	0
Johnson Municipal Building	All landscape trees	12	1
Johnson Library	All landscape trees	3	0
Johnson Firestation	All landscape trees	1	0
Johnson Elementary School	All landscape trees	15	0
Lamoille View Cemetery	All landscape trees	44	0
Old Mill Park	All landscape trees	18	5+
Whiting Hill Cemetery (Corner of 15 and 100C)	All landscape trees	10	0

Appendix B: Full Species and Genera List for Johnson Village's Public Trees

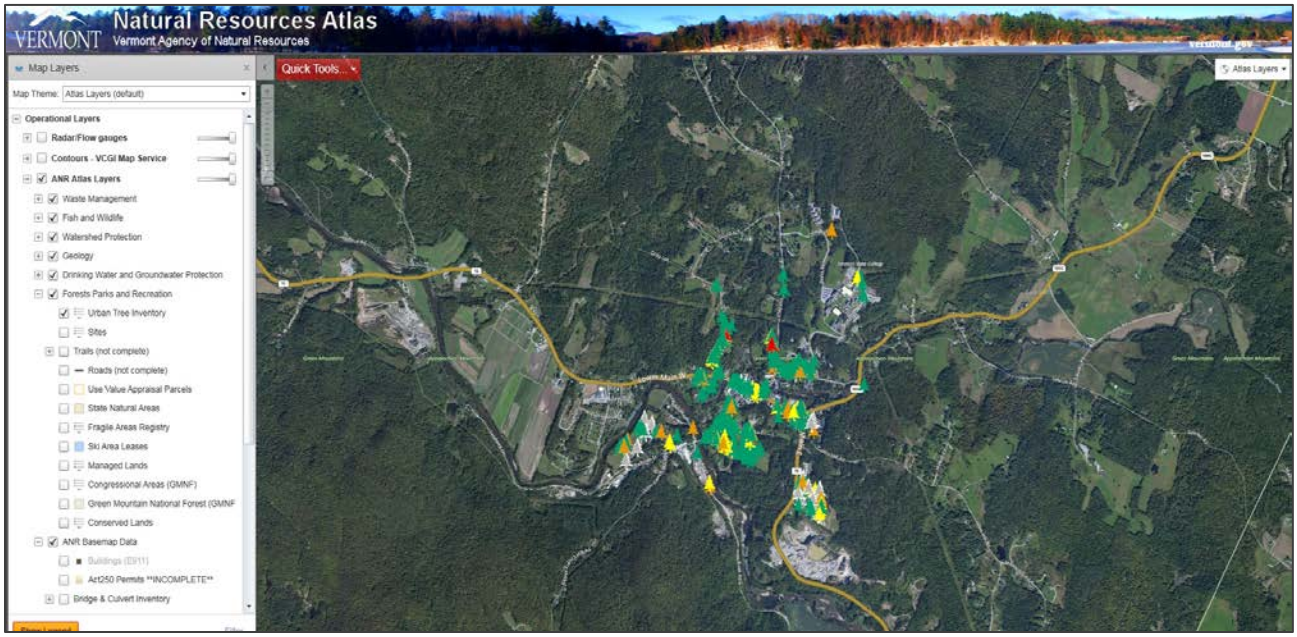



Percent Genera Composition
Percent of Total Number of Trees
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
34.71
14.33
8.26
8.26
4.68
4.13
4.13
3.31
2.75
2.75
2.48
1.93
1.38
1.38
1.10
0.83
0.83
0.55
0.55
Acer (maple)
Pinus (pine)
Betula (birch)
Fraxinus (ash)
Malus (apple)
Picea (spruce)
Quercus (oak)
Syringa (lilac)
Thuja (cedar)
Ulmus (elm)
Prunus (cheery)
Tsuga (hemlock)
Gleditsia (locust)
Populus (poplar)
Gymnocladus (coffeetree)
Amelanchier (serviceberry)
Broadleaf
Abies (fir)
Conifer
Genera

Appendix C: Instructions for Accessing Public Tree Data in ANR Atlas

Anyone with internet access can view all of the inventoried Johnson public trees by using the Vermont Agency of Natural Resources' (ANR) Atlas mapping tool. Follow these simple steps:

1. Set your web browser to http://anrmaps.vermont.gov/websites/anra/
2. Zoom in to Johnson using the +/- scale navigation tool in the upper left portion of the map (the tree data layer won't show up unless you are zoomed in to the town-level so that you can see the street names on the map).
3. In the information pane on the left of the screen switch over to the "map layers" tab at the bottom.
4. Expand the "Forests, Parks, & Recreation" heading,
5. Click on the box to the left of "Urban Tree Inventory" to load public tree data (it might take a moment for the layer to load).
6. Once you see all the trees on the map, you can zoom in and right-click on any individual tree and click on "What's here"; when you do this, the left information pane will change to give you the basic details for that specific tree.
    - To access all of the information collected on that specific tree, click on the grey text title of the tree in the left pane and a new window will open with all of the inventory data.
    - In this new window there are three tabs: "Details" and "Attributes" display the same information in different formats and if a photo was taken of the tree, it will show up in the "Attachments" tab.

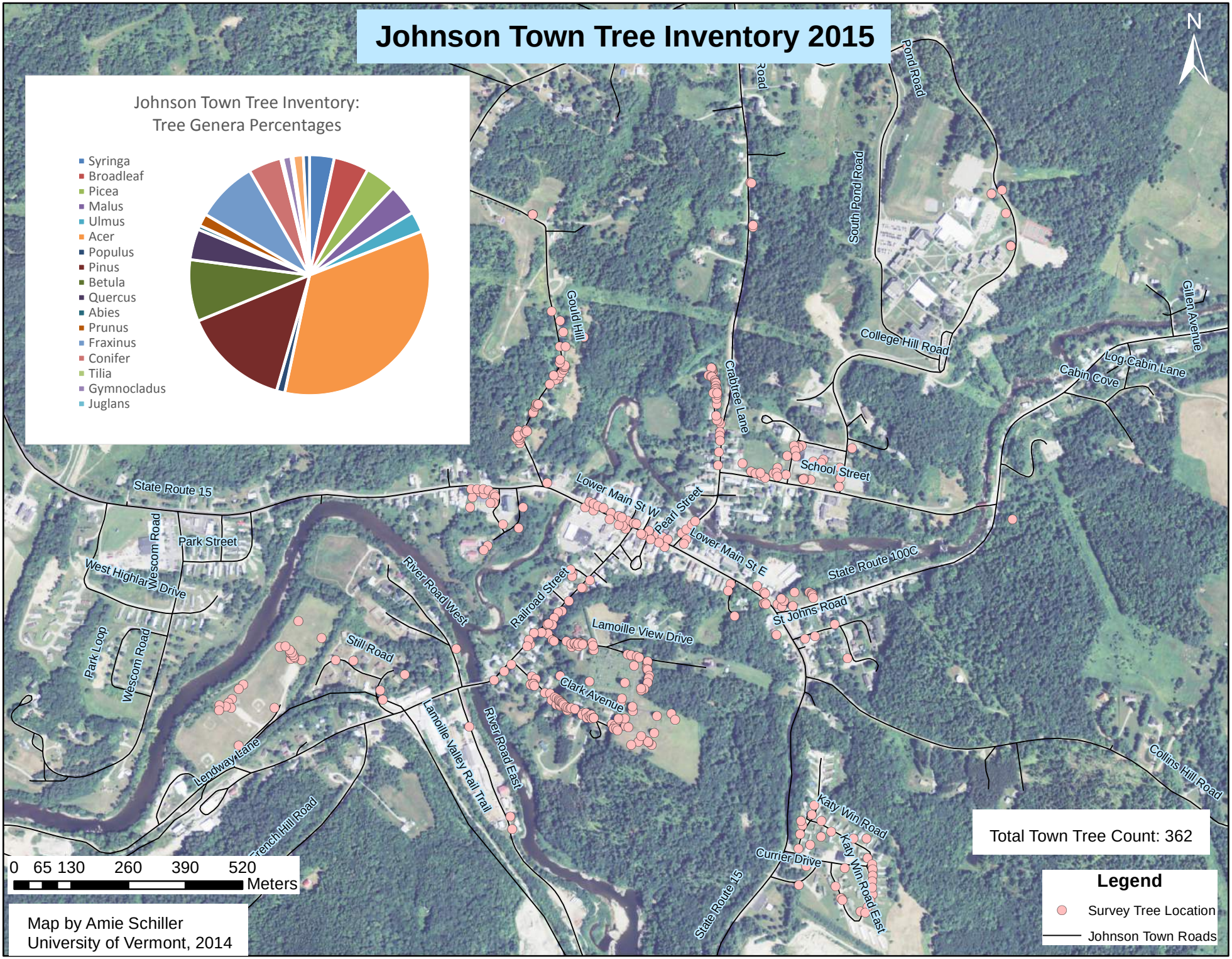


Screen shot of the Johnson public trees as seen through the ANR Atlas mapping tool.

Appendix D: Maps

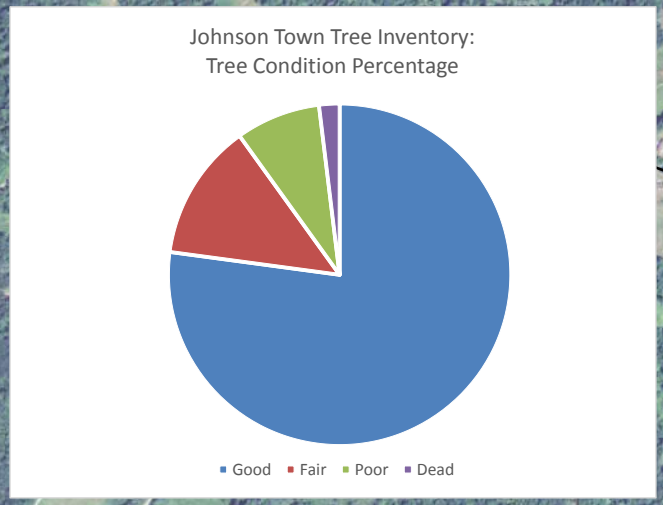
- All trees inventoried in Johnson Village
- All trees inventoried, by condition class
- Trees requiring a consultation
- All trees inventoried, by size (DBH) class
- Potential tree planting locations within the ROW or on town-owned property

Johnson Town Tree Inventory 2015



Map by Amie Schiller
University of Vermont, 2014

Johnson Town Tree Inventory: Condition Classes



Tree Condition:

Good: 280 Trees
Fair: 47 Trees
Poor: 29 Trees
Dead: 7 Trees

Legend

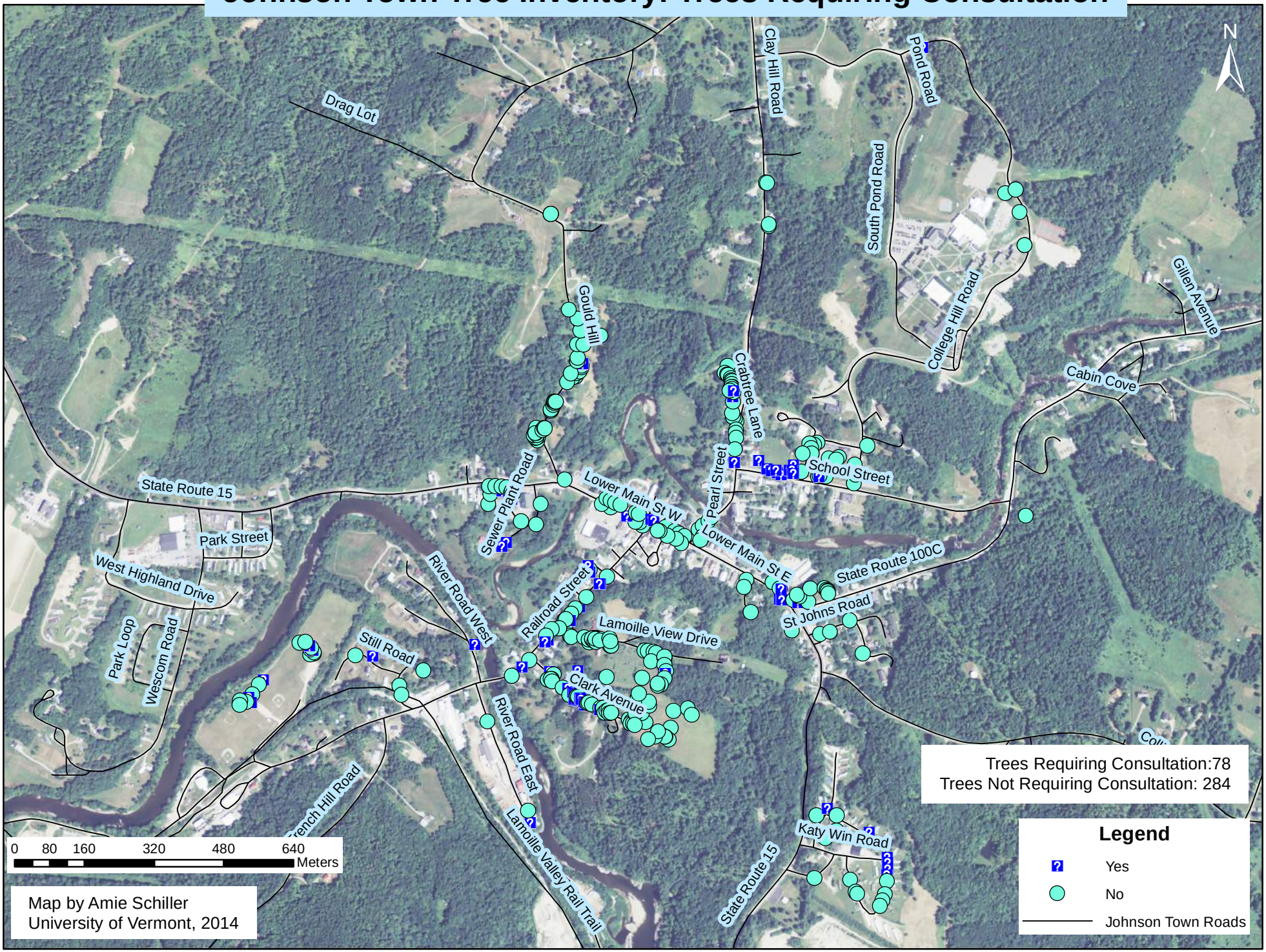
Survey Tree Condition

- Good
- Fair
- Poor
- Dead
- Johnson Town Roads

0 75 150 300 450 600 Meters

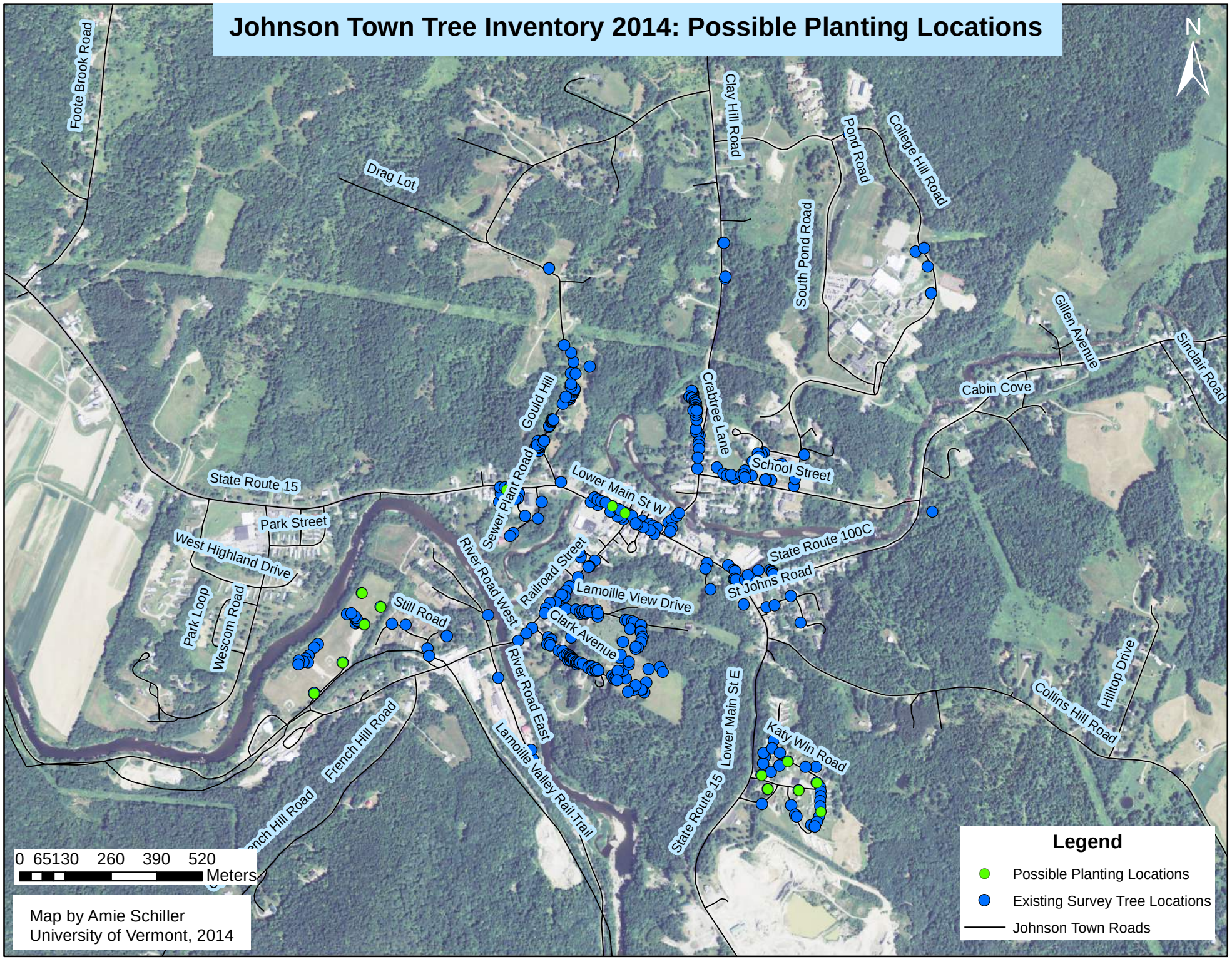
Map by Amie Schiller
University of Vermont, 2015

Johnson Town Tree Inventory: Trees Requiring Consultation



Johnson Town Tree Inventory: Tree Diameter Classes

Map by Amie Schiller
University of Vermont, 2014


Johnson Town Tree Inventory 2014: Possible Planting Locations
N
Foote Brook Road
Drag Lot
Clay Hill Road
Pond Road
College Hill Road
South Pond Road
Gillen Avenue
Sinclair Road
Cabin Cove
Crabtree Lane
Gould Hill
Sewer Plant Road
School Street
Lower Main St W
State Route 15
Park Street
West Highland Drive
River Road West
Railroad Street
State Route 100C
St Johns Road
Lamoille View Drive
Clark Avenue
Still Road
Park Loop
Wescom Road
River Road East
Lower Main St E
Katy Win Road
Collins Hill Road
Hilltop Drive
French Hill Road
Lamoille Valley Rail Trail
State Route 15
0 65130 260 390 520
Meters
Map by Amie Schiller
University of Vermont, 2014
Legend
Possible Planting Locations
Existing Survey Tree Locations
Johnson Town Roads